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THE CURRENT SITUATION OF MASTICATORY BEHAVIOR OF FIRST GRADER AT ELEMENTARY SCHOOL: A RELATIONSHIP BETWEEN MASTICATORY ABILITY AND STUDENTS' LIKES AND DISLIKES

Naomi Sakuma

*Student, Doctoral Course, Graduate School of Engineering Kanagawa Institute of Technology,
Ohka Elementary School of Yokohama City, Kanagawa, Japan*
naomi12077@gmail.com

Naomi Aiba

Professor, Graduate School of Engineering Kanagawa Institute of Technology, Kanagawa, Japan
aiba@bio.kanagawa-it.ac.jp

Momoyo Kawamura

Undergraduate Student, Kanagawa Institute of Technology, Kanagawa, Japan
peachyoyo719@gmail.com

Ryosuke Katayama

Dr. Researcher, Kanagawa Institute of Technology, Kanagawa, Japan
ryosukegv9@gmail.com

Hidenobu Takao

Professor, Graduate School of Engineering Kanagawa Institute of Technology, Kanagawa, Japan
takao@rm.kanagawa-it.ac.jp

Abstract

Twenty percent of first-graders of a public elementary school in Kanagawa Prefecture were unable to masticate school lunch properly. Teachers encouraged masticate training at school, but it showed no improvement. The purpose of this research was to investigate the characteristics of mastication to find possible methods and more specific mastication education. The subjects were 100 first graders (6~7years old) at public elementary school where school lunch was served with an individual tray. The survey was conducted during school lunchtime by recording the bread crust eating situation. Every student was provided with 8g of bread crust cut into three equal parts. Within one month, on the days when kibinago (herring-like forage fish), cabbage, potatoes, curry rice, bonito, and komatsuna (Japanese Spinach) were served, the subjects were asked about their "Likes or Dislikes" and the food was "Easy to Masticate or Hard to Masticate". The average of masticatory time during eating bread crust was 76 seconds, the maximum was 151 seconds, and the minimum was 19 seconds. The average of masticatory frequency was 72 times, the maximum was 155 times and the minimum was 27 times. The average masticatory speed was 58 beats per minute (bpm), the fastest was 113 bpm and the slowest was 29 bpm. The most favorite dish was curry rice (99%) and the least favorite dishes were kibinago and bonito (13%, respectively). The highest percentage (27%) of the subjects answered bonito dish as "Hard to Masticate" and the lowest percentage (1%) was curry rice. "Dislike" was significantly associated with "Hard to Masticate" in cabbage ($p<0.01$) and bonito ($p<0.01$). The first graders had individual differences in masticatory behavior. It was suggested that "Likes and Dislikes" are related to masticatory ability. If the children practice the mastication of solid foods before entering school, the children might eat more smoothly.

Keywords

Masticatory Behavior, Elementary School, Masticatory Ability, Food Preference

1. Introduction

Labor and Welfare's Infant Nutrition Survey, the percentage of students with difficulty to masticate food was twice as large as 10 years ago according to the 2005 Ministry of Health. A previous study showed that masticatory behavior was improved by nutrition education with the picture-story show. However, the daily continuation is not easy (Sato, Hayashi, & Yoshiike, 2013).

Our pilot study showed that 20% of the first graders' elementary school spit up of food from the mouth during eating school lunches, did not mash them in purees, or did not swallow them. And to improve it, teachers urged students to eat with masticatory well at school lunch and home, but the students' masticatory ability did not improve. We also found that some foods which were difficult to masticated and others were easy.

The Guideline of Nutrition and Diet Education and Promotion at The Third Version issued by The Ministry of Agriculture, Forestry and Fisheries includes items as a goal of "mastication and eat slowly" which intended to prevent obesity (Otsuka, et al., 2006).

More and more households have a habit of eating ready-made & take out foods recently.

This change in dietary habits causes one of the difficulties for children to eat a variety of food in school lunch. The problems are various and include not only "eat fast" but also "cannot chew well (masticatory ability)", "chew poorly (masticatory behaviour)" and "chew very slow" (Sato & Yoshiike, 2011).

Also, many children have an unbalanced diet. The number of children who "likes and dislikes" is increasing, and obesity and puberty emaciation are increasing from an unbalanced diet (Sato & Yoshiike, 2011). However relationship between children's "likes and dislikes" and "cannot chew well (masticatory ability)" is unknown. Therefore the purpose of this study was to investigate the relationship between the characteristics of mastication and the likes and dislikes of the first grader at elementary.

2. Methods

2.1. Subjects

The mastication status of about 100 elementary first graders (6~7years old) were recorded during lunch on May 7th, 2019. And the number of mastication, time, and speed were analyzed from the recorded data.

This study was approved by the Ethical Review Board for the use of human subjects of Kanagawa Institute of Technology (No.2018-072).

2.2. Video Camera Setting

Video recording was referred to previous study with showing the characteristics of mastication by video recording (Kita, Kawashima, & Mitsudo, 2015) and also this study decided to analyze the characteristics of mastication in elementary first-grader from video recordings.

The masticatory status of about 100 elementary first graders was recorded during lunch on May 7th, 2019. And the number of mastication, time, and speed were analyzed from the recorded data. Analysts performed the same person more than once to minimize errors. Four stickers were placed around the corners of the child's mouth so that the chewing state could be accurately understood (Figure 1).



Figure 1: *4 Stickers were put around the Corner for Mastication Positional Information*

The recording camera was mounted on a tripod, placed in the center of a four-seater desk, and secured to the desk with a board and tape to prevent movement (Figure 2).



(a)

The Camera was attached on the Board with Tape

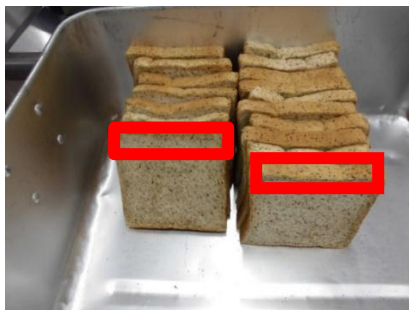


(b)

The Camera was set up in the center of the Desk for Recording
Figure 2: Camera Setting for Recoding around 360°Viewing

2.2.1. Preparing Test Food

The ingredients to be eaten were bread crust (Itoh, 1989), which are difficult to masticate (Figure 3).



(a) *Breads for test
Crusts*



(b) *Each bread crust was
cut at one side of the
bread at 8g*



(c) *One side of the bread
crust was cut into three
equal parts.8g per side, cut
into 2.6g divided into three*

Figure 3: Preparing Bread Crust for Masticatory Test

2.2.2. Video Recording during Eating

The children drank a sip of milk and damp their throat before eating the bread crust. After that, they started eating bread crust and decided not to eat anything other than bread crust until they had finished eating bread crust. The children were monitored by video during eating bread crust. A trained nutrition teacher counted the masticatory frequency from the recorded data. The chewing time was calculated from the recording display time.

2.3. Questionnaire Survey for Food Preferences and Mastication.

A nutrition teacher took a questionnaire on “Likes or Dislikes” “Easy to Masticate or Hard to Masticate” in May 2019. The ingredients were three kinds of food which are difficult to masticate and other which were easier to masticate total six " kibinago (herring-like forage fish)", "cabbage", " bonito ", " curry rice ", " potatoes", and " komatsuna (Japanese Spinach) ". After the children had a bite to eat, the nutrition teacher asked.

2.4. Relationship between the Number of Teeth and Mastication

Dental examination results (total number of teeth (deciduous teeth plus permanent teeth), number of deciduous teeth, number of permanent teeth, number of cavities) in June 2019, and the relationship between masticatory time, masticatory frequency, and masticatory speed were investigated.

2.5. Statistical Analysis

The mastication was monitored from the start of chewing with the back teeth until swallowing all. One count of chewing was taken when the seal on the corner of the mouth moved. The masticatory time was measured in seconds from the display time of the video camera. The speed was calculated in bite per minute (BPM).

The preferences and the status of mastication by questionnaires were analyzed statistically with the Chi-square test or Fisher's exact test, the relationship between teeth and mastication is Spearman's rank correlation coefficients in IBM SPSS Statistics ver.26 (Tokyo, Japan).

3. Results

3.1. Distribution of Mastication Status

The mastication time was measured for each child to eat the test bread crust completely. The average of mastication time of bread crust was 76 sec, the minimum was 19sec, and the maximum was 151sec (Figure 4).

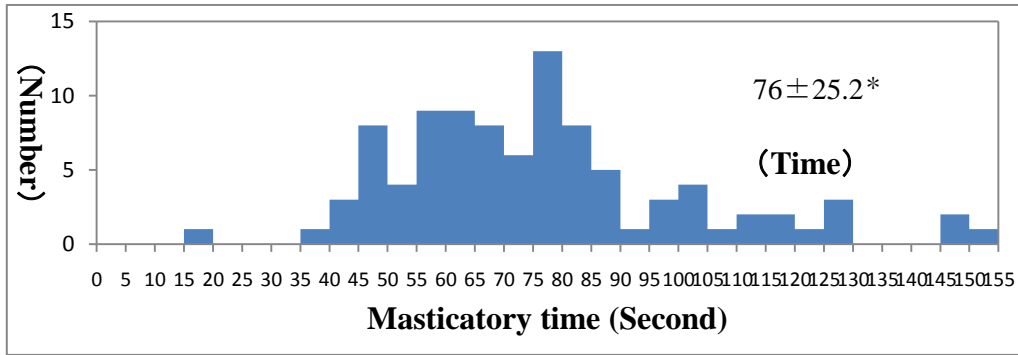


Figure 4: Distribution of Masticatory Time

*Average ± Standard deviation

The mastication frequency was counted the mastication during eating bread crusts. It was distributed between 27 times and 155 times, and the average was 72 times (Figure 5).

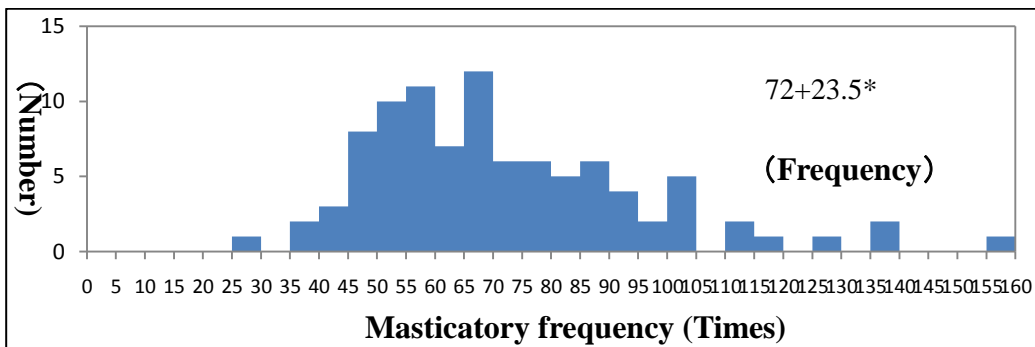


Figure 5: Distribution of masticatory frequency

*Average ± Standard deviation

The mastication speed was calculated by dividing chewing frequency with mastication time. It was from 29 bpm to 113, the average was 58 bpm (Figure 6). Individual differences were large among three indicators as mastication abilities.

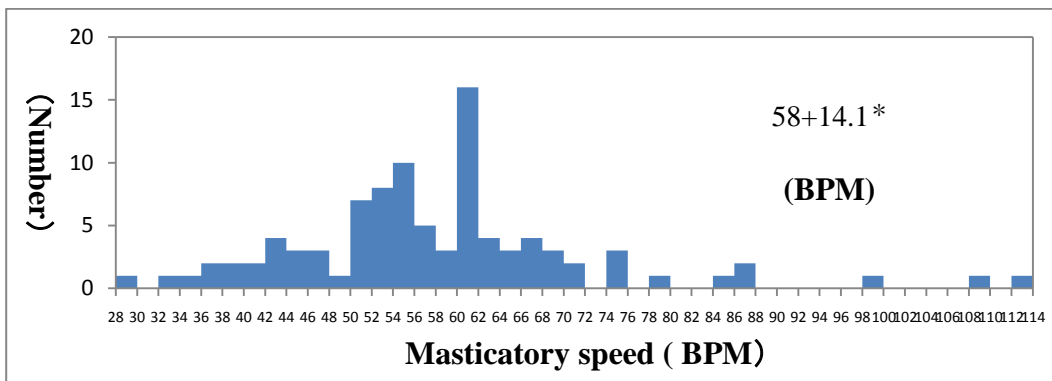


Figure 6: Distribution of masticatory speed

*Average ± Standard deviation

3.2. Preferences and Mastication

The relationship between Food preference and masticatory ability was statically analyzed with chi-square test or Fisher’s exact test.

The cabbage salad was prepared by being cut at 5mm and steamed (Figure 7). The more students who liked cabbage answered cabbage could be masticated well than those disliked, significantly ($p < 0.001$) (Figure 8).



Figure 7: Cabbage Dishes

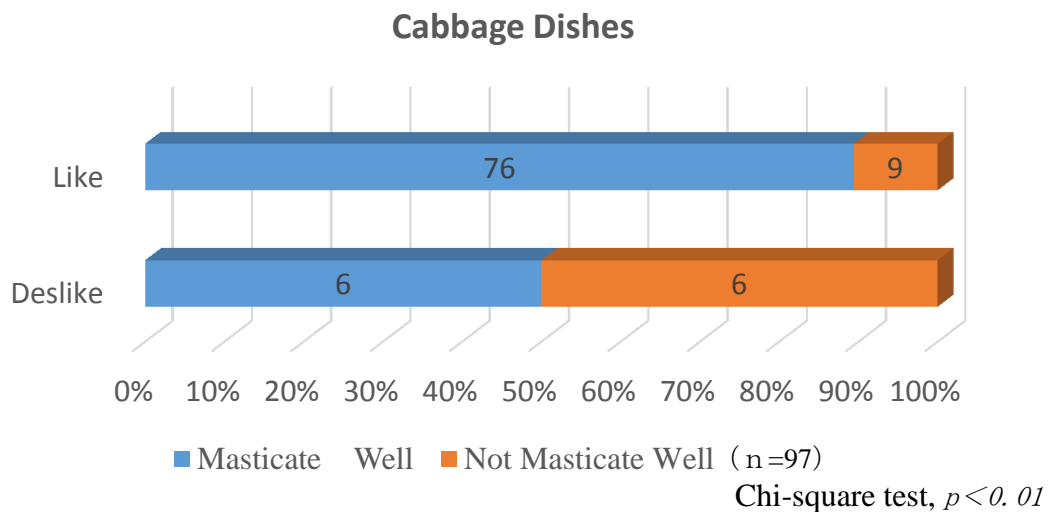
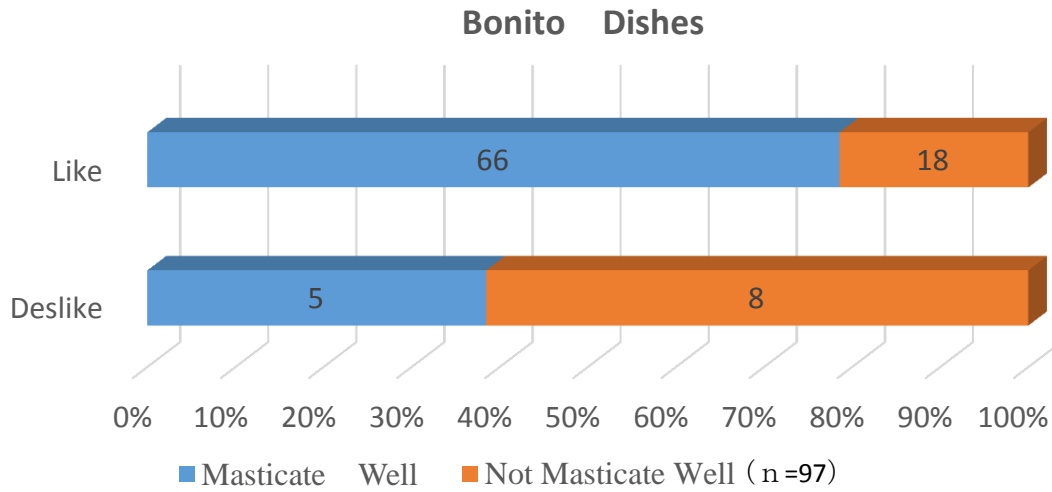


Figure 8: Relationship between Likes and Dislikes of Cabbage Dishes and Mastication Well

The bonito was cut at 1.5cm square and fried with sesame seeds (Figure.9). The more students who liked bonito answered bonito as “Chew well” than those disliked, significantly ($p < 0.05$) (Figure 10).



Figure 9: Bonito dishes



Chi-square test, $p < 0.05$

Figure 10: Relationship between Likes and Dislikes of Bonito Dishes and Mastication Well

Potato sauté all ingredients of curry rice and Komatsuna in miso soup were prepared by boiling and there were no relationships between preferences of these foods and mastication (Figure 11-18).



Figure 11: Potato Dishes

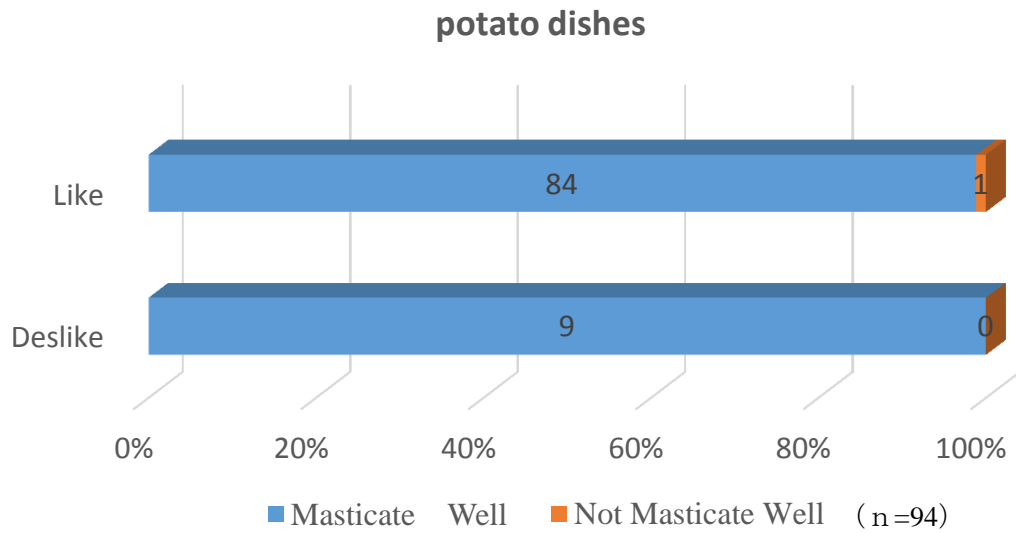


Figure 12: Relationship between Likes and Dislikes of Potato Dishes and Chewing Well



Figure 13: Curry Rice

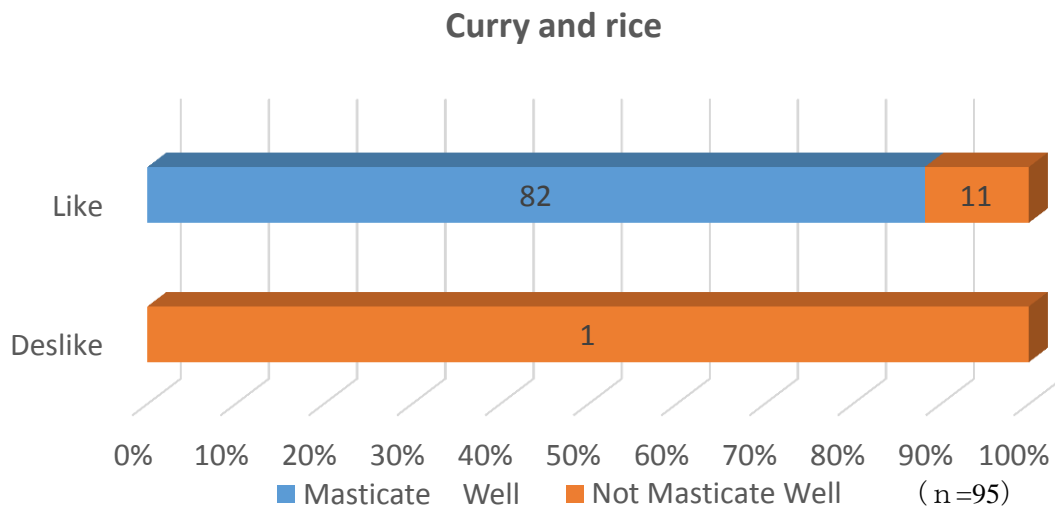


Figure 14: Relationship between Likes and Dislikes of Curry and Rice and Mastication Well



Figure 15: Komatsuna Miso Soup

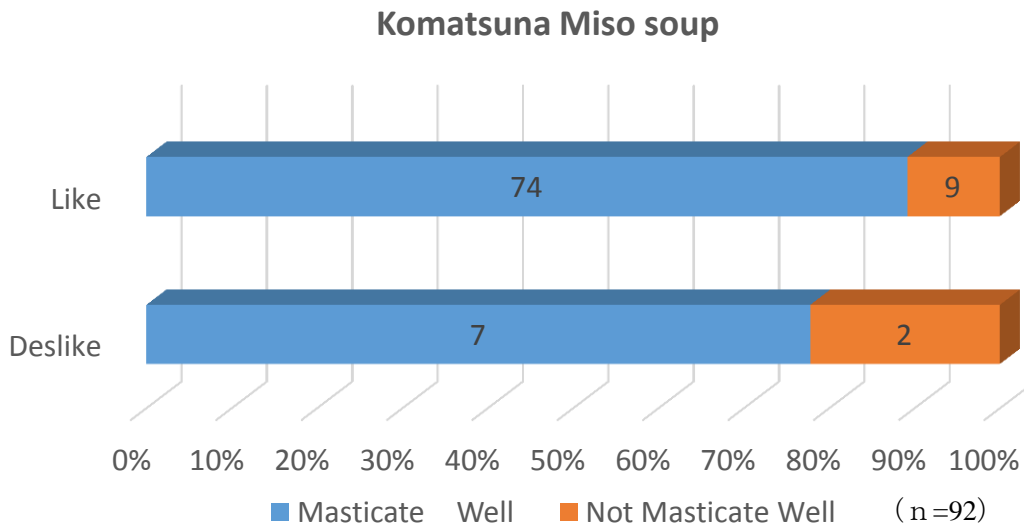


Figure 16: Relationship between Likes and Dislikes of Komatsuna Miso Soup and Mastication Well

Potato dish and Curry rice were students’ favorite dishes and only one student answered “Dislike”, respectively.

Kibinago fly was prepared by frying and almost 90% of both students who liked and disliked kibinago answered to masticated well (Figure 18).



Figure 17: Kibinago Dishes

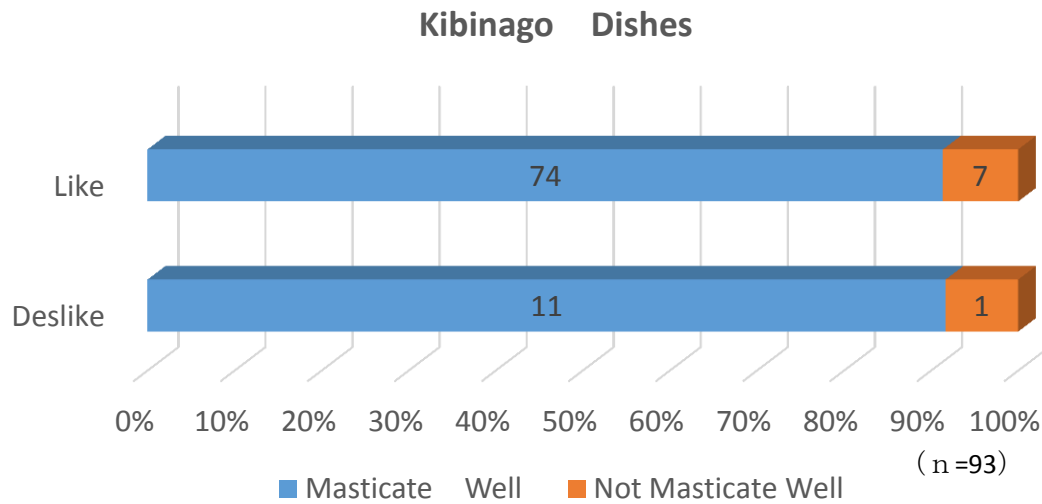


Figure 18: Relationship between Likes and Dislikes of Kibinago Dishes and Mastication Well

No significant relationship was obtained between "number of teeth (total number of teeth deciduous teeth plus permanent teeth), number of deciduous teeth, number of permanent teeth, number of cavities)" and "masticatory time, masticatory frequency, and masticatory speed". Only the relationship between the number of cavities teeth and the masticatory frequency was a significant tendency (Table 1).

Table 1: Relationship between the number of Teeth and Mastication

	Chewing frequency			Chewing time			Chewing speed		
	n	p-value*	Correlation coefficient	n	p-value*	Correlation coefficient	n	p-value*	Correlation coefficient
Number of teeth (deciduous+ permanent teeth)	92	0.738	-0.035	92	0.944	-0.007	92	0.746	-0.034
Number of deciduous teeth	92	0.123	0.163	92	0.218	0.129	92	0.917	-0.110
Number of permanent teeth	92	0.193	-0.137	92	0.312	-0.106	92	0.977	-0.003
Number of cavities teeth	92	0.086	0.18	92	0.227	0.127	92	0.497	0.071

* Spearman's rank correlation coefficients

No significant difference

4. Consideration

The previous study suggested that the masticatory movements of children were not necessarily stable compared to adults (Saito, Hayasaki, Nakata, Iwasa, & Nakata, 2004).

It became clear that individual differences were also large and unstable in the first graders of elementary in this survey. There's a possibility that the number of children who can masticate in the future education will increase because the individual differences were large.

University student eating behavior surveys reported that they choose junk food avoided healthy vegetables, as a result, they gained weight (Teves & Narciso, 2017).

Even with the knowledge of healthy food, students who choose junk food should learn the value of a healthy meal (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005).

This study also showed that the relationship between Masticatory Ability and Students' food preference, and it is considered necessary to provide coaching on improving faddiness from the time of school age.

The evaluation of mastication includes two types, masticatory behavior as "not masticated" and masticatory ability as "cannot be masticated" (Sato & Yoshiike, 2011). It has been clarified that the reason for not being able to masticate well is the relationship with motor ability factors (Okazaki, Takahashi, & Oku, 1999). Also, the development of muscles, bones, and nerves associated with mastication increases the occlusal force and crushing force for enhancing mastication ability. In this way, it is said that coordinated movements that control masticatory muscles, bones, and nerves will be mature.

In the first graders at elementary school, it could be assumed that some children had poor mastication abilities because of immature athletic abilities. As far as the results of this survey were concerned, some children still had phenomena such as "eat with mouth open (16.7%)" and "eat with the finger in the mouth (2.1%)" observed in infancy.

There was a significant difference between the hard bonito and the cabbage with a lot of fiber in the ingredients and "I don't like it because cannot masticate it well" or "I cannot masticate it because I don't like it well". In the future, there is a possibility that "the masticatory function can be improved by improving uneven eating" and "improvement of uneven eating can be improved by masticatory training".

It was referred that masticatory teaching with cooperative movement of the whole body is difficult (Okazaki et al., 1999). In previous research on bouncing rhythm learning which is the same

whole-body cooperative movement, it was referred that when playing music suitable for that movement, children felt the nuance and texture of the rhythm and could to jump with good rhythm (Okubo, 2020). Therefore, we will consider the development of music that children can masticate well with good rhythm.

5. Conclusions

In the first graders of elementary school, the mastication times at the maximum was 8 times the minimum, the mastication frequency was 4 times, and the BPM was 6 times, with showing the individual differences in masticatory behaviors were large. Cabbage and bonito were the foods as “disliked as could not masticate well” or “could not masticate well as dislike”, suggesting that likes and dislikes related to masticatory ability or masticatory ability related to like and dislike.

As a limitation of this study, the effect of sampling bias by setting subjects in a limited school could not be excluded, as this research was carried out at one school. Moreover, it was not possible to evaluate it by an objective study on the direct occlusal force. We would like to increase the number of subjects to be surveyed at several schools located in different regions, make an objective evaluation of direct bite force in the future and consider educational methods that can improve mastication at school.

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